

THE VARIETIES OF *LUZULA ACUMINATA*<sup>1</sup>

JOHN E. EBINGER

The woodrush, *Luzula acuminata*, is confined to the eastern United States and Canada where it is of rather sporadic occurrence. This early-blooming species is usually restricted to moist open woodlands but is occasionally found along roadsides and in other open areas. It was not until the work of Rafinesque (1840) that the specific distinctions between this North American species and the European species *L. pilosa* were noticed. Even here Rafinesque mentions that this North American species, *L. acuminata*, is perhaps *L. pilosa*. Before this time the American species was combined with *L. pilosa*, although Schultes and Schultes (1829) and Hooker (1840) considered it a variety of *L. pilosa*.

Watson (1879) also considered that the North American species was specifically distinct and, apparently unaware of Rafinesque's earlier name, proposed for it the name *Luzula carolinae*. Later, Fernald (1903), also apparently unaware of the earlier name by Rafinesque, proposed the name *L. saltuensis* for the North American species. In contrast, he considered *L. carolinae* to represent a local species of the Carolina mountains, similar to the Asiatic species *L. plumosa*.

There has been a difference of opinion concerning the treatment of the *Luzula acuminata* complex. Some authors have treated this complex as being one species, others as two species and others as varieties of one species. In most instances the two entities are recognized as varieties and both Fernald (1950) and Gleason (1952), in the two major floras of the northeastern United States, treat the species in this manner. In both cases the two varieties are separated on the basis of the number of secondary pedicels in the inflorescence though Fernald (1950), also mentions that the color of the perianth may differ.

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Jones (1950) used the binomial *Luzula saltuensis* in his flora of Illinois since he does not agree with Fernald regarding the name *L. acuminata*. Jones (1951) suggests that this name should be rejected as a *nomen dubium* because, in his opinion, Rafinesque's description is ambiguous. He objects to the fact that Rafinesque described the North American plant as having glabrous leaves that are less than three inches long; an inflorescence which is congested and not exceeding the leaves; and flowers that are small.

When considering fruiting material the objections of Jones are well founded; however, with respect to flowering material Rafinesque's description is correct. The leaves in young material, particularly the cauline ones, are less than three inches long and quite glabrous except for the silky marginal hairs that are usually present in all *Luzula* species. Also, some specimens of this species have been found that are completely glabrous. In young flowering material the inflorescence is congested and does not exceed the leaves and the flowers are small. In my opinion the description by Rafinesque is not correct when fruiting material is considered, but is when young flowering material is used. Furthermore, the fact that Rafinesque states that the inflorescence is corymbose and that the plant is closely related to *L. pilosa*, excludes any other Eastern North American species of *Luzula*.

Though Rafinesque's description leaves no doubt as to which species he was referring, it is impossible to determine with certainty which of the two entities (*acuminata* or *carolinae*) he was describing. However, the fact that he mentions that the type locality is boreal America indicates he was referring to the northern variety (var. *acuminata*). Furthermore, this same interpretation was made by Fernald (1944) when he considered the northern entity to be variety *acuminata* and reduced *Luzula carolinae* S. Wats. to a variety of *L. acuminata*. Along with this confusion concerning the correct name there is some lack of agreement as to whether one or two species are involved. In this paper it will be shown that there is only one species in this complex, but that there are two varieties that can be separated



and that each has a distinct geographic distribution.

#### MATERIALS AND METHODS

The basis of this study was herbarium material, and more than 200 collections from Northeastern United States and Canada were studied. The herbarium specimens were examined for the characters mentioned below and a diligent search was also made for any additional morphological criteria which might be of significance. For determination of anther and filament lengths flowering material was used since after the pollen is discharged there is a slight decrease in anther size. For all other measurements and observations mature fruiting specimens were studied. Finally, the results obtained were plotted on a map to show the geographic distribution of the two varieties.

All material used in this study was obtained from the U.S. National Herbarium (US), the Gray Herbarium (GH), and the Yale University herbarium (YU).

#### DISCUSSION

To separate the two varieties of *Luzula acuminata*, Fernald (1938) used the relative lengths of the filaments and anthers, the length of the bracts at the base of the inflorescence, the color of the perianth segments, and the forking rays of the inflorescence. The present study has revealed that most of these characters are completely unreliable: in fact, the only usable trait is the forking rays of the inflorescence (secondary pedicels that develop just beneath the flowers to form a compound corymb).

The anther and filament of every flowering specimen was measured and it was found that there is no appreciable difference in the two series. In variety *carolinae* the average filament length is 0.5 mm and the anther length is 1.2 mm, while in variety *acuminata* the average length is 0.4 mm for the filament and 1.4 mm for the anther. Not only are the lengths very similar, but the variation overlaps so that it is impossible to distinguish between the two series by using this character.

Measurements were also made of the bract at the base of the inflorescence. In both varieties the length is nearly the same and it is always shorter than the fruiting inflores-



cence. Fernald (1938) mentions that the type of variety *carolinae* has the inflorescence overtopped by an erect frondose bract. Upon careful examination of this type specimen (Gray and Carey, July 1841), it was found that the frondose bract, mentioned by Fernald, is actually the upper cauline leaf. Above this leaf is a small bract that does not overtop the inflorescence.

Fernald (1938) also mentions that castaneous perianth segments are common in variety *carolinae*. A number of specimens of this variety do have castaneous sepals and petals, but this character is also found in some specimens of variety *acuminata* and therefore cannot be used to separate the two entities. Also, some specimens of variety *carolinae* have stramineous to light brown perianth segments, a characteristic which is common in variety *acuminata*.

The only reliable character found to separate the two varieties is the number of forking rays, i.e. secondary pedicels, in the inflorescence. In variety *acuminata* the number of primary pedicels in the corymbose inflorescence varies from 7 to 16 with an average of 10 or 11. Secondary pedicels are usually lacking in this variety, but occasionally one or two are found. When secondary pedicels occur they are restricted to one or two of the primary pedicels. Also, they are usually restricted to one inflorescence of the specimen while the other inflorescences lack secondary pedicels. In variety *carolinae*, in contrast, the inflorescence is always a compound corymb with the number of primary pedicels varying from 9 to 18 and with an average of 12 or 13. In all the inflorescences of a specimen of this variety, many of the primary pedicels have at least one secondary pedicel growing from them. Sometimes 2, 3 or 4 secondary pedicels are found on one or more of the primary pedicels. The average number of secondary pedicels found in an inflorescence of this variety is 8 or 9 but some inflorescence have as many as 20. Since variety *acuminata* sometimes has a few secondary pedicels in the inflorescence the ratio of the number of secondary pedicels to the number of primary pedicels was used as a means of separating the two varieties.



In scoring this character the primary and secondary pedicels in all of the inflorescences of each specimen were counted. From this count the ratio of the number of secondary to primary pedicels was found and the results were then plotted on a map (Fig. 1) to determine if the two

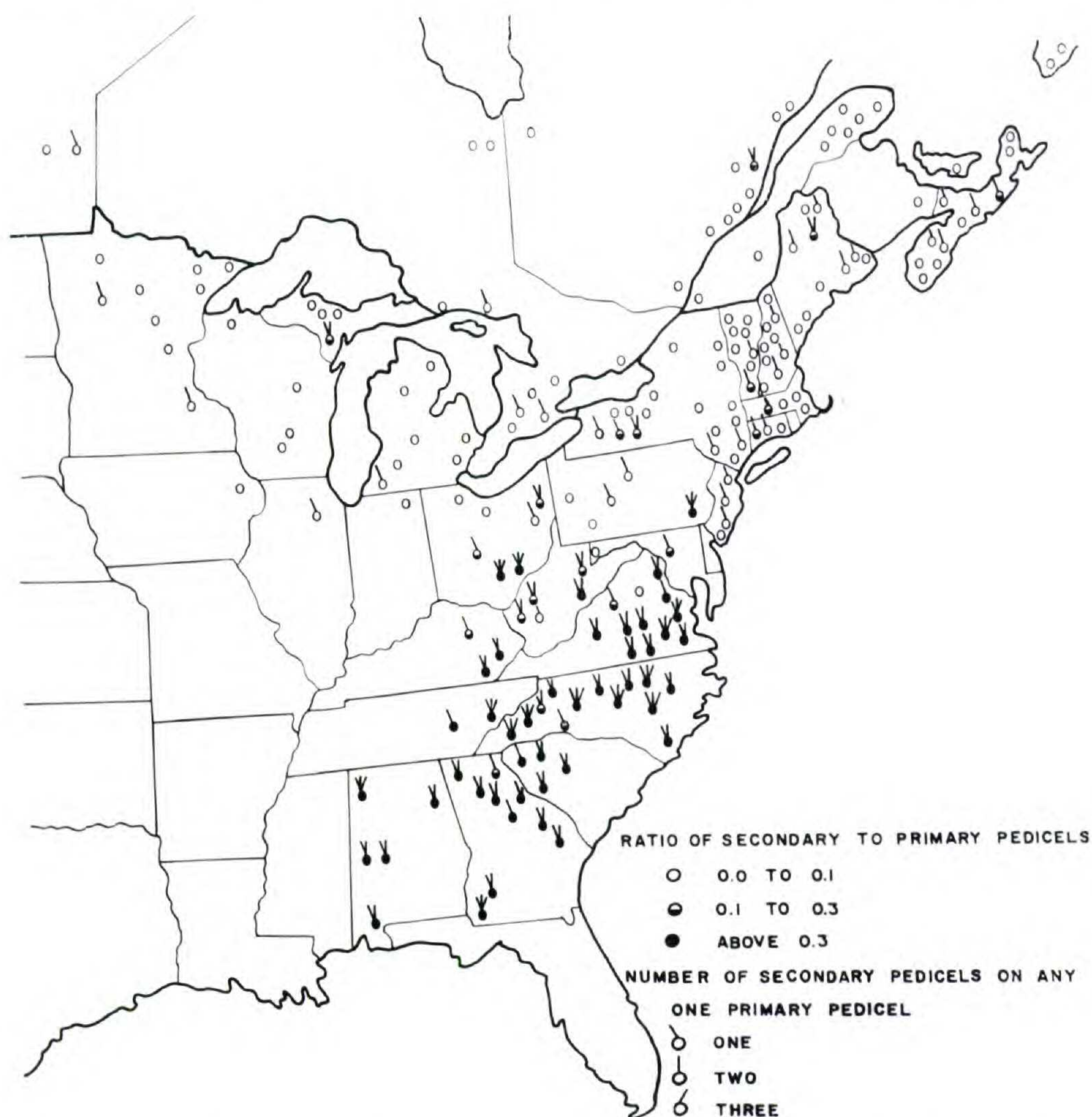


FIG. 1. Map showing the distribution of *Luzula acuminata* var. *acuminata* and *Luzula acuminata* var. *carolinae*. The open circles indicate specimens of variety *acuminata*, the darkened circles indicate specimens of variety *carolinae* and the half darkened circles indicate specimens that are intermediate between the two varieties with respect to the ratio of the number of secondary pedicels to primary pedicels. The bars radiating from the circles indicate the number of secondary pedicels that are present on any one of the primary pedicels of the inflorescence.

series have different geographic distributions. On this map an open circle indicates that the ratio is between 0 and 0.1 while a half darkened circle indicates a ratio between 0.1



and 0.3 and a completely darkened circle indicates that the ratio is greater than 0.3.

The number of secondary pedicels on any one primary pedicel is also indicated on the map. This character is shown by the bars radiating from the circle. A bar radiating from the left of the circle indicates that at least one primary pedicel in the inflorescence has one secondary pedicel growing from it, while a bar radiating from the top of the circle indicates that at least one primary pedicel has two secondary pedicels growing from it, and a line radiating from the right indicates that three secondary pedicels are present on at least one primary pedicel.

As can be seen from the map, variety *carolinae* has a southern distribution which extends from Alabama and Georgia, west to the Mississippi River, and north to southern Ohio and Pennsylvania. In contrast, variety *acuminata* has a more northern distribution. The southern boundary of this variety is southern Ohio and Pennsylvania, and in the west it extends to South Dakota and Manitoba, Canada. It is also common in southeastern Canada and the New England States.

In general, the region of high variability between the two varieties includes the states of Ohio, Pennsylvania, southern New York, West Virginia, Maryland and New Jersey. In this region of high variability there are numerous intermediate plants as well as some plants that are typical of both varieties. Excluding this region of high variability the two varieties are fairly constant in their characters. Variety *carolinae*, which is represented by the darkened circles with several bars radiating from them, is the southern variety. Of the 50 specimens studied from this area all but six have a ratio greater than 0.3. Of these six specimens, five have a ratio between 0.1 and 0.3 and the remaining specimen has a ratio of 0.0 and should be referred to variety *acuminata*. Also, most of the southern specimens have 2, 3 or more secondary pedicels growing from at least one primary pedicel in an inflorescence.

The northern variety (*acuminata*) is not as constant in its characters, but there can be no doubt in distinguishing



the two series. Of the 125 specimens studied from this region, 92 lack secondary pedicels. In the remaining 33 specimens, only eight have a ratio of secondary pedicels to primary pedicels between 0.1 and 0.3 while the remainder have a ratio of less than 0.1. No specimens were found with a ratio greater than 0.3. Also, of the 33 specimens that have secondary pedicels, only five have more than one secondary pedicel growing from any of the primary pedicels of the inflorescence, and in most cases no more than one secondary pedicel was found in an inflorescence.

The secondary pedicels found in the southern variety do not seem to be a result of a longer growing season. Even in young flowering specimens the flowers on the secondary pedicels are as well developed as the flowers on the primary pedicels, and both produce seed at nearly the same time. This indicates that the existence of secondary pedicels is not a result of the environment but that it is a genetically controlled factor.

#### TAXONOMIC TREATMENT

Since the results of this paper show that there are two varieties in this complex, a short taxonomic treatment of the two will be undertaken. This should help to clarify the nomenclature of the varieties since in the past there has been confusion as to the correct name.

*Luzula acuminata* Raf. Autikon Bot. 193. 1840

var. *acuminata*

*Luzula pilosa* (L.) Willd. var.  $\beta$ . *Americana* Schultes & Schultes Syst. Veg. 7:262. 1829.

*Luzula pilosa* (L.) Willd. var.  $\beta$ . Hook. Fl. Bor.-Am. 2: 188. 1840.

*Luzula saltuensis* Fern. Rhodora 5:195. 1903.

*Juncoides saltuense* (Fern.) Heller, Muhlenbergia 6:12. 1910.

*Juncoides pilosum* (L.) Coville var. *michiganense* Farwell, Rep. Mich. Acad. Sci. 20:170. 1918.

*Juncoides pilosum* (L.) Coville var. *saltuense* (Fern.) Farwell, Rep. Mich. Acad. Sci. 20:170. 1918.

*Luzula carolinae* S. Wats. var. *saltuensis* (Fern.) Fern. Rhodora 40:404. 1938.



This is the northern variety and can be separated from the more southern variety by the lack of secondary pedicels in the inflorescence. In specimens where secondary pedicels exist the ratio is always less than 0.3 and rarely is there more than one secondary pedicel to any one primary pedicel.

***Luzula acuminata* Raf. var *carolinae* (S. Wats.)**

Fern. Rhodora 46:5. 1944

*Luzula carolinae* S. Wats. Proc. Am. Acad. 14:302. 1879.

*Juncodes carolinae* (S. Wats.) O. Ktze. Rev. Gen. Pl. 2:724. 1891.

This variety has a much more southern distribution than variety *acuminata*. It can be distinguished from the more northern entity by the larger number of secondary pedicels in the inflorescence. Usually some of the primary pedicels have two or more secondary pedicels growing from them.

CONCLUSIONS

The above results show conclusively that there is a distinct difference between the two varieties and that each has a definite geographic range. Variety *acuminata* has a more northern distribution than variety *carolinae* and can easily be separated from the latter by its lack of secondary pedicels in the inflorescence. In the specimens of variety *acuminata* that do have secondary pedicels the ratio of these to the primary pedicels is always less than 0.3 and in most cases there is no more than one secondary pedicel to any of the primary pedicels. Just the opposite condition exists in the southern variety (*carolinae*). Here a ratio above 0.3 is always found and the ratio is sometimes greater than 1.0. Also most specimens of this southern variety have two or more secondary pedicels on some of the primary pedicels of the inflorescence.

In the region of high variability between the two series are a number of specimens that are difficult to place taxonomically. The large amount of variability in this region as well as the specimens of the northern variety that have secondary pedicels show that the two series intergrade into each other. This variability indicates that only two varieties are involved and that they are not separate species.



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REPRESENTATIVE SPECIMENS: *Luzula acuminata* Raf. var. *acuminata* UNITED STATES: South Dakota; *E. J. Palmer* 37562 (GH). Minnesota: *Butters & Abbe* 10 (GH); *J. W. Moore* 21601 (US); *J. B. Moyle* 387 (US); *Pease & Bean* 26387 (GH); *Rosendahl* 4966 (GH); *Rosendahl & Butters* 4614 (GH). Iowa: *Thorne* 10005 (US). Wisconsin: *Colby* 4472 (US); *Fassett* 2751 (GH) 2744 (GH). Michigan: *Farwell* 2559 (GH), 4817 (GH), 4864 (GH), 5421 (GH). New York: *A. J. Eames* 290 (GH); *Haberer* 962 (GH); *House* 8817 (GH), 9346 (GH), 21354 (GH), 22402 (GH); *McVaugh* 4066 (GH); *Muenschler & Bachtel* 104 (US); *Phelps* 282 (GH, US); *Wherry & Muenschler* 15308 (GH); *Wiegand* 1968 (GH). Pennsylvania: *Fogg* 12124 (GH). Maryland: *Hermann* 14936 (US). Virginia: *Hunnnewell* 18931 (GH). New Jersey: *Long* 31981 (GH), 37425 (GH), 37478 (GH). Connecticut: *Ebinger* 90 (YU); *Parker* 5492 (YU); *Weatherby* 2403 (YU). Massachusetts: *Hill & St. John* 1698 (YU). New Hampshire: *Bissell* 1498 (YU); *Edmondson* 4189 (GH); *A. H. Moore* 3408 (US). Maine: *Fellows* 1768 (US), 2368 (US); *Fernald* 85 (GH, US, YU), 2510 (GH); *Ricker* 180 (US); *St. John & Nichols* 2203 (YU, US). Indiana: *Deam* 44268 (GH). CANADA: Ontario: *Hosie, Losee & Bannan* 1512 (GH); *Dutilly & Lepage* 36312 (US); *Montgomery* 1069 (GH); *Soper* 2652 (GH). Quebec: *Chrysler* 1181 (US); *Collins, Fernald & Pease* 5462 (GH); *Dutilly & Lepage* 15036 (GH); *Rouleau* 1689 (GH); *Rousseau* 2621 (GH, US); *St. John* 1824



(GH); *Marie-Victorin* 28491 (GH); *Marie-Victorin & Rolland-Germain* 25793 (GH, US), 27117 (GH), 29264 (GH), 45674 (GH), 47459 (GH). Prince Edward Island: *Fernald & St. John* 10988 (GH). Nova Scotia: *Bissell & Linder* 20733 (GH); *Fernald & Long* 23583 (GH); *Long & Linder* 20732 (GH), 20735 (GH); *Nichols* 79 (YU), 542 (YU, GH); *Pease & Long* 20734 (GH, US). Newfoundland: *Pease & Edgerton* 27216 (GH).

*Luzula acuminata* Raf. var. *carolinae* (S. Wats.) Fern. UNITED STATES: Alabama: *Harper* 3703 (GH, US), 3956 (US). Georgia: *Allard* 81 (US), 82 (US); *Cronquist* 4979 (GH); *D. Eyles* 6863 (GH); *Harper* 2056 (GH, US), 2062 (GH, US); *Hermann* 10186 (GH); *Muenschner & Smith* 2954 (GH). South Carolina: *House* 1847 (US); *E. J. Palmer* 35405 (GH). North Carolina: *Correll* 5020 (GH); *Godfrey* 3414 (GH), 3814 (GH); *Godfrey, Campana & Fox* 48070 (GH); *Godfrey & Fox* 50307 (GH); *Godfrey, Fox & Woods* 49111 (GH); *Godfrey & White* 7013 (GH, US); *Gray & Carey* (July, 1841) (GH-HOLOTYPE); *House* 4130 (US); *Hunnewell* 10272 (GH), 14188 (GH). Tennessee: *Hunnewell* 15158 (GH); *Nease* 194 (US). Kentucky: *McInterr & Shacklette* 615 (US). Ohio: *Leonard* 551 (US), 552 (US). West Virginia: *Dickey* 244 (GH); *Fosh* 1034 (US). Virginia: *Fernald & Long* 6958 (GH), 6959 (GH), 6960 (GH), 6961 (GH), 7787 (GH), 7788 (GH), 14526 (GH); *Fernald, Long & Abbe* 14123 (GH); *Fernald, Long & Pease* 11657 (GH, US), 11658 (GH); *Grimes* 3400 (GH).

## THE OCCURRENCE OF SPIRODELA OLIGORRHIZA IN THE UNITED STATES

EDWIN H. DAUBS<sup>1</sup>

*Spirodela oligorrhiza* (Kurz) Hegelm. of the Lemnaceae was first reported and described by Kurz (1867) from India under the binomial *Lemna oligorrhiza*. Shortly thereafter Hegelmaier (1868) transferred the species to the genus *Spirodela*, and reported its further occurrence in Australia and Java. At the same time he also described and named four varieties. Later (1896) he gave each of these varieties species status.

The species remained unreported outside of this Far Eastern area until Saeger (1934) recorded it from two locations in Missouri. The first of these was made by him in Swope Park, Kansas City, and the second by F. H. Woods from a pond in southwestern Missouri. It is also reported that this pond contained goldfish, indicating the probability

<sup>1</sup>Department of Botany, University of Illinois, Urbana.